The role of overweight and obesity in urinary tract infection in children

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SUMMARY

This study was conducted to determine the relationship between overweight/obesity and UTI in children. A comparison was made, in terms of overweight and obesity, between 135 children with UTI (case group) and 135 healthy children (control group). UTI was diagnosed through urine culture.
Dimercaptosuccinic acid renal scanning (DMSA) was also used to distinguish between lower UTI and acute pyelonephritis. Overweight and obesity were determined based on standard body mass index (BMI) curves. There were 12 (8.8%) overweight and 26 (19.2%) obese children in the case group. Four (3.0%) overweight and five (3.7%) obese children were found in the control group. There was a significant difference between the two groups regarding overweight and obesity frequencies. However, no such difference existed between children with cystitis and acute pyelonephritis. This study showed a significant relationship between overweight/obesity and UTI. Therefore, overweight and obesity may play a role in the pathogenesis of UTI in children.

Keywords: overweight, obesity, cystitis, acute pyelonephritis, children.

INTRODUCTION

Urinary tract infection (UTI), a common disease in children, develops following the invasion of pathogens, especially bacteria, to the urinary system. Based on available data, 1% of boys and 3% of girls experience UTI in the first decade of life. Moreover, the probability of recurrent UTI in girls is 40% [1].
While the disease may manifest as cystitis, acute pyelonephritis, and asymptomatic bacteriuria, acute pyelonephritis is the most severe form [2]. Serious complications of UTI, *e.g.* hypertension, renal scar and chronic renal failure, can be prevented through prompt diagnosis, appropriate treatment, and risk factor control [3, 4]. UTI risk factors include age, obstruction of urinary tract, vesicoureteral reflux, neurogenic bladder, etc. [5]. A question was raised for the researchers of this study on whether other factors such as overweight and obesity can be a risk factor for UTI. The increasing trend of obesity in children and adolescents is currently considered as a health hazard for children [6]. According to the National Health and Nutrition Examination Survey (NHANES), 20.6% of 2 to 5 years children and 30.3% of 6-11 years children are overweight and obese, respectively [6]. Although a large body of literature has focused on the role of obesity in the development of various diseases such as diabetes, hypertension and cardiovascular diseases in children, few studies have evaluated the effects of obesity on the incidence of UTI in children [7-10]. Given the importance of UTI risk factor identification, this study was performed to evaluate the relationship between overweight / obesity and UTI in children.

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PATIENTS AND METHODS

This case-control study was conducted in Qazvin Children hospital during two years (2012-13). This hospital is the only tertiary pediatric hospital in Qazvin state and is affiliated to Qazvin University of Medical Sciences (Qazvin, Iran). It compared 135 children with UTI (case group) with 135 healthy children (control group) in term of overweight and obesity. All children were aged between 2 months and 12 years old. The sample size was calculated to provide 95% confidence coefficient and 80% power in statistical analysis [9]. Consecutive sampling continued until the desired sample size was reached. The inclusion criteria for case group were:

1) having clinical signs and symptoms of UTI such as fever, abdominal pain, frequency, dysuria, etc.;
2) positive urine culture (urine culture positive for more than 10^5 CFU/mL of a single pathogen in a midstream urine sample or clean catch method or 10^4 CFU/mL of a single pathogen via urinary catheterization, or presence of any number of colonies of an organism in urine culture taken by suprapubic method;
3) circumcised boys [5].

Children with known UTI risk factors such as vesicoureteral reflux, ureteropelvic junction obstruction (UPJO), ureterovesical junction obstruction (UVJO), hydronephrosis, hydroureter, urinary tract stone, neurogenic bladder, vaginal adhesion, constipation, and underlying diseases (such as malnutrition and septicemia) were excluded. Renal ultrasound and dimercaptosuccinic acid (DMSA) renal scan were performed during the first two and seven days of hospitalization, respectively. DMSA renal scan (gold standard) were used to distinguish between acute lower UTI and acute pyelonephritis. Acute pyelonephritis was confirmed by observing focal or diffuse areas of diminished uptake associated with preservation of renal cortical outline in DMSA renal scan [5]. The ultrasound and voiding cystourethrogram (VCUG) were carried out by a radiologist, and the renal DMSA scan was performed and interpreted by a nuclear medicine specialist. All patients were studied under similar conditions. Group matching was applied to select 135 healthy children (control group) who presented to the hospital for vaccination or elective surgeries such as tonsillectomy. The two groups were matched in terms of age and gender. The children's weight and height were measured using standard methods [13]. Body mass index (BMI) was calculated by dividing weight (kg) to height squared (m^2). BMI measurements between the 85th and 95th percentiles and over the 95th percentile for children of the same age and sex were defined as overweight and obesity, respectively [6, 13]. Chi-square test and t-test and Mann-Whitney U were applied to analyze the obtained data. All analyses were performed with SPSS for Windows 16.0 (SPSS Inc., Chicago, IL, USA). $P<0.05$ was considered statistically significant.

Ethical considerations

The ethics committee of the Research Department in the Qazvin University of Medical Sciences (Project No. 997) approved the study. All parents were provided information regarding the research method in simple language. The children were included in the study after their parents agreed and signed the informed consent form.

RESULTS

The case group included 26 boys and 109 girls; in the control group there were 21 boys and 114 girls (P=0.42) (Chi-square test). The median ±IQR of age was 59.4±26.1 and 55.6±29.8 months (range: 24-128 months) in the case and control groups, respectively (P=0.06) (Mann-Whitney U test). There was no significant difference between two groups

Table 1 - Comparison of overweight and obesity in case and control groups.

BMI percentiles (kg/m^2)	*Case group (n=135)*	*Control group (n=135)*	*P*
<85%	97	126	0.01
85-95% (overweight)	12	4	
>95% (obesity)	26	5	

Chi-Square test.

Table 2 - Comparison of overweight and obesity in children with cystitis and acute pyelonephritis groups.

BMI percentiles (kg/m²)	*Cystitis (n=81)*	*Acute pyelonephritis (n=54)*	*P*
<85%	55	42	0.39
85-95% (overweight)	9	3	
>95% (obesity)	17	9	

Chi-Square test

Table 3 - Relationship between overweight and obesity with frequency of UTI in case group.

BMI percentiles (kg/m²)	*First attack (n=84)*	*More than once attack (n=51)*	*P*
<85%	61	36	0.841
85-95% (overweight)	8	4	
>95% (obesity)	15	11	

Chi-Square test.

Table 4 - Relationship between overweight and obesity with gender in case group.

Sex	*BMI*			*P*
	Overweight n=12 (%)	*Obesity n=26 (%)*	*Normal n=97 (%)*	
Male	1 (8.3)	2 (7.7)	18 (18.5)	0.30
Female	11 (91.6)	24 (92.3)	79 (81.5)	
Total	12 (100)	26 (100)	97 (100)	

Chi-Square test.

in terms of age and gender. The case group contained 12 (8.8%) overweight and 26 (19.2%) obese children. These values in control group were 4 (3.0%) and 5 (3.7%), respectively. There was significant difference between thetwo groups regarding the frequency of overweight and obesity (Table 1).

There was no significant difference between children with lower UTI (cystitis) and those with acute pyelonephritis and also, between one and more than once attack of UTI groups regarding frequency of overweight and obesity (Tables 2 and 3). Neither overweight, nor obesity was significantly related with gender (P=0.300) (Table 4).

DISCUSSION

The results of the present study suggest a significantly higher rate of UTI among overweight/obese children than in their healthy counterparts. Few studies have been performed in this regard in children. The study of Yang et al. on children younger than three years showed that the prevalence of overweight and obesity in children with febrile urinary tract infection was significantly higher than controls. These researchers introduced obesity as a risk factor for acute pyelonephritis in children [10].

Another study conducted by Semins et al. revealed a frequency of UTI 2.5 times higher in obese subjects than in non-obese children older than five years. They reported a significant relationship between obesity and UTI in males, *i.e.* increased BMI (30.0-44.9 kg/m²) was associated with greater incidence rate of UTI. However, the relationship between obesity and UTI in females was only significant when BMI value was between 30 and 34.9. Finally, these researchers introduced the obesity as a risk factor for UTI and acute pyelonephritis [9].

The study of Saliba et al. on population older than 18 years showed a direct relationship between BMI and UTI, mainly in males [14]. Another study found an increased risk of UTI after surgery in obese people compared to non-obese people [15]. Ribera et al. examined 289 female and 168 male diabetic patients with and without asymptomatic bacteriuria. They concluded that obesity was a major risk factor for symptomatic

UTI in men [16]. Geerlings et al. detected a significant relationship between BMI and asymptomatic bacteriuria, but failed to establish a relationship between obesity and symptomatic UTI [17]. In contrast to the above-mentioned studies, Hammar et al. did not find a significant relationship between BMI and UTI in adults with type II diabetes [18]. In the current study, the frequency of UTI was significantly related with overweight and obesity, *i.e.* UTI was respectively three and five times more prevalent among overweight and obese children than in healthy subjects. As children with risk factors of UTI (vesicoureteral reflux, urinary system abnormalities, vaginal adhesion, constipation, etc.) were excluded in the present study and also, the two groups matched in terms of gender, age, and socioeconomic factors, overweight and obesity can be suggested as risk factors for UTI in children. Although the exact mechanism of impaired immune function and increased susceptibility to infections, including UTI, in obese individuals is unknown, factors such as chronic low-grade systemic inflammation, altered adipokine signaling, and systemic metabolic dysfunction are believed to be involved [19].

Adipose tissue produces various proinflammatory cytokines such as leptin, adiponectin, and tumor necrosis factor-α [20]. In an experimental study on rats, Yim et al. stated that since obesity increased the incidence of renal inflammation and progressive kidney disorders, it elevated the risk of UTI and acute pyelonephritis [21, 22]. Lack of arginine and glutamine along with sympathetic hyperactivity can also be responsible for the mentioned relationship [24, 25]. Blanc et al. justified the increased risk of UTI in obese individuals by suppressed production of tumor necrosis factor-α and increased production of nitric oxide consequent to lack of arginine and glutamine [23]. According to Takeda et al. and Yang et al., sympathetic hyperactivity in obese people can increase prostate volume, voiding dysfunction, and finally the incidence of UTI [24, 25]. In conclusion, based on our findings, overweight and obesity may have a role in the pathogenesis of UTI in children. We suggest that BMI should be monitored in every child with UTI. Also, we recommend that overweight and obesity must be declared as UTI risk factor in paediatric medical curriculum resources.

Conflict of interest: We declare no conflict of interest.

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